

MELON-HEADED WHALE (*Peponocephala electra*): Hawaiian Islands Stock Complex: Hawaiian Islands & Kohala Resident Stocks

STOCK DEFINITION AND GEOGRAPHIC RANGE

Melon-headed whales are found in tropical and warm-temperate waters throughout the world. Although largely considered oceanic, photo-identification studies and other lines of evidence indicate the presence of island-associated populations in several locations (Brownell 2009). Small numbers have been taken in the tuna purse-seine fishery in the eastern tropical Pacific, and they are occasionally killed in direct fisheries in Japan and elsewhere in the western Pacific. Melon-headed whales in Hawaiian waters appear to prey primarily upon a large diversity of cephalopods, and fish species (West *et al.* 2018). Summer/fall shipboard surveys of the waters within the U.S. Exclusive Economic Zone (EEZ) of the Hawaiian Islands resulted in one sighting in 2002, one in 2010, and seven in 2017 (Figure 1; Barlow 2006, Bradford *et al.* 2017, Yano *et al.* 2018).

Photo-identification and telemetry studies suggest there are two demographically-independent populations of melon-headed whales in Hawaiian waters, the Hawaiian Islands stock and the Kohala resident stock.

Resighting data and social network analyses of photographed individuals indicate very low rates of interchange between these populations (0.0009/yr) (Aschettino *et al.* 2012). This finding is supported by genetic analyses that indicate significant differentiation between the Kohala residents and other melon-headed whales sampled in Hawaiian waters, despite overall high levels of interchange among most populations sampled (Martien *et al.* 2017), suggesting differences in social organization and foraging behavior may drive the observed structure. Some individuals in each population have been seen repeatedly for more than a decade, implying high site-fidelity for both populations. Individuals in the larger Hawaiian Islands stock have been resighted throughout the main Hawaiian Islands. Satellite telemetry data revealed distant offshore movements, nearly to the edge of the U.S. EEZ around the Hawaiian Islands (Figure 2), with apparent foraging near cold and warm-core eddies (Woodworth *et al.* 2012). Individuals in the smaller Kohala resident stock have a range restricted to shallower waters of the Kohala shelf and west side of Hawaii Island (Aschettino *et al.* 2012, Oleson *et al.* 2013). Satellite telemetry data indicate they occur in waters less than 2500m depth around the northwest and west shores of Hawaii Island, west of 156° 45' W and north of 19° 15' N (Oleson *et al.* 2013). The northern boundary between the two stocks provisionally runs through the Alenuihaha Channel between Hawaii Island and Maui, bisecting the distance between the 1000 m depth contours (Oleson *et al.* 2013). Genetic analysis showed the strongest differentiation between animals sampled at Palmyra Atoll and other locations (Martien *et al.* 2017).

For the Marine Mammal Protection Act (MMPA) stock assessment reports, there are two Pacific management stocks within the Hawaiian Islands EEZ (Oleson *et al.* 2013): 1) the Kohala resident stock, which includes melon-headed whales off the Kohala Peninsula and west coast of Hawaii Island and in less than 2500m of water, and 2) the Hawaiian Islands stock, which includes melon-headed whales inhabiting waters throughout the U.S. EEZ of the Hawaiian Islands, including the area of the Kohala resident stock, and adjacent high seas waters. At this time, assignment of individual melon-headed whales within the overlap area to either stock requires photographic-identification of the animal. Because data on abundance, distribution, and human-caused impacts are largely lacking

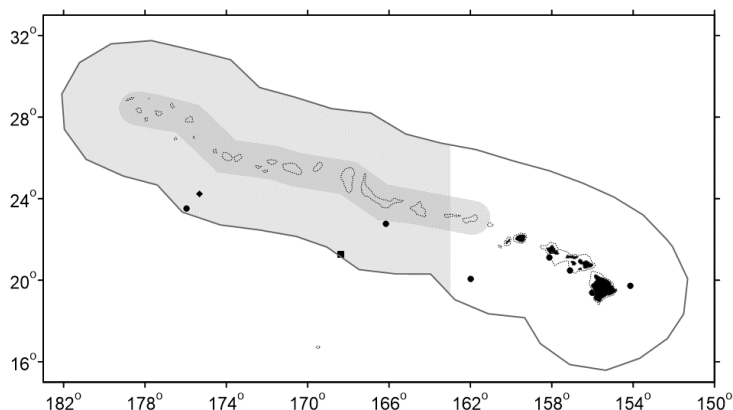


Figure 1. Melon-headed whale sighting location during the 2002 (diamond), 2010 (circle), and 2017 (square) shipboard surveys of U.S. EEZ waters surrounding the Hawaiian Islands (Barlow 2006, Bradford *et al.* 2017, Yano *et al.* 2018). Outer line represents approximate boundary of survey area and U.S. EEZ. Dark gray shading indicates the original Papahānaumokuākea Marine National Monument, with the lighter gray shading denoting the full 2016 Expansion area. Dotted line represents the 1000 m isobath.

for high seas waters, the status of the Hawaiian Islands stock is evaluated based on data from U.S. EEZ waters of the Hawaiian Islands (NMFS 2005).

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

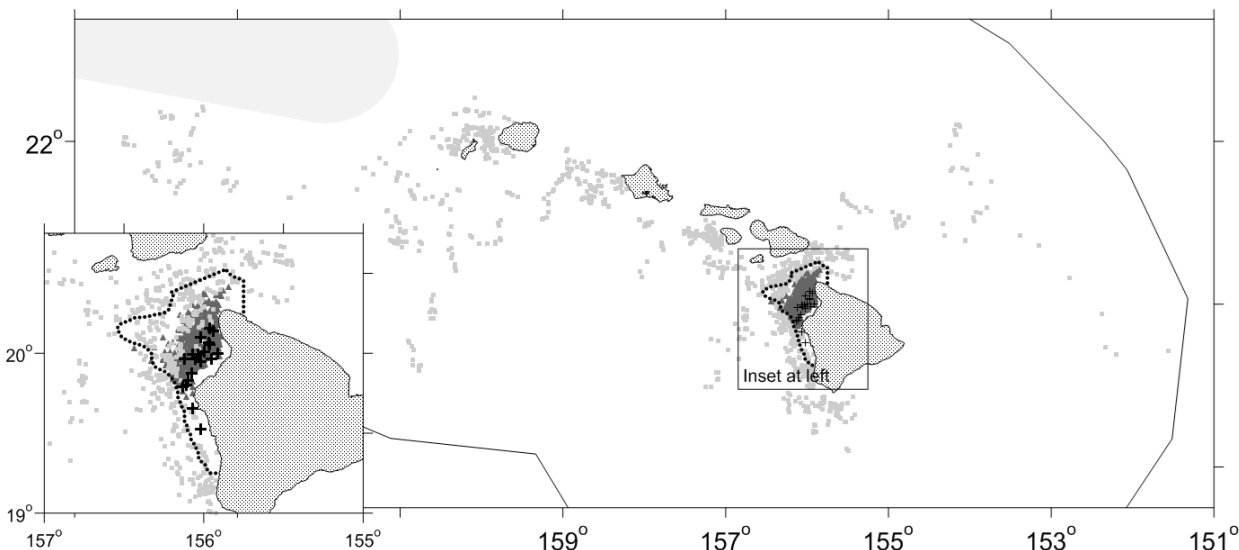


Figure 2. Sighting locations of melon-headed whales identified as being part of the Kohala resident stock (crosses) and telemetry records of Kohala resident (dark gray triangles) and Hawaiian Islands (light gray squares) melon-headed whale stocks (Oleson *et al.* 2013). The dotted line around waters adjacent to the northwest and west shores of Hawaii Island represents the provisional stock boundary for the Kohala resident stock (Oleson *et al.* 2013). The Kohala resident stock and the Hawaiian Islands stocks overlap throughout the range of the Kohala resident stock. Outer line represents U.S. EEZ. Gray shading indicates area of Papahānaumokuākea Marine National Monument.

Information on fishery-related mortality and serious injury of cetaceans in U.S. EEZ of the Hawaiian Islands waters is limited, but the gear types used in Hawaii fisheries are responsible for marine mammal mortality and serious injury in other U.S. fisheries. Entanglement in gillnets and hooking or entanglement in various hook and line fisheries have been reported for small cetaceans in Hawaii (Nitta and Henderson, 1993). No interactions between nearshore fisheries and melon-headed whales have been reported in Hawaiian waters. No estimates of human-caused mortality or serious injury are currently available for nearshore hook and line or gillnet fisheries because these fisheries are not observed or monitored for protected species bycatch. Long-term photo-identification studies have noted individuals from both the Kohala Resident and Hawaiian Islands stocks with bullet holes in their dorsal fin or with linear scars on their fins or bodies (Aschettino 2010) which may be consistent fisheries interactions.

There are currently two distinct longline fisheries based in Hawaii: a deep-set longline (DSL) fishery that targets primarily tunas, and a shallow-set longline (SSL) fishery that targets swordfish. Both fisheries operate within U.S. waters and on the high seas. Between 2014 and 2018, no melon-headed whales were observed hooked or entangled in the SSL fishery (100% observer coverage) or the DSL fishery (18-22% observer coverage) (Bradford 2018a, 2018b, 2020, Bradford and Forney 2017,). However, three unidentified delphinids were taken in the DSL fishery, some of which may have been melon-headed whales.

Other Mortality

In recent years, there has been increasing concern that loud underwater sounds, such as active sonar and seismic operations, may be harmful to beaked whales (Cox *et al.* 2006) and other cetaceans, including melon-headed whales (Southall *et al.* 2006, 2013) and pygmy killer whales (*Feresa attenuata*) (Wang and Yang 2006). The use of active sonar from military vessels has been implicated in mass strandings of beaked whales and recent mass-stranding reports suggest some delphinids may be impacted as well. A 2004 mass-stranding of 150-200 melon-headed whales in Hanalei Bay, Kauai occurred during a multi-national sonar training event around Hawaii (Southall *et al.* 2006).

Although data limitations regarding the position of the whales prior to their arrival in the Bay, the magnitude of sonar exposure, behavioral responses of melon-headed whales to acoustic stimuli, and other possible relevant factors preclude a conclusive finding regarding the role of Navy sonar in triggering this event, sonar transmissions were considered a plausible cause of the mass stranding based on the spatiotemporal link between the sonar exercises and the stranding, the direction of movement of the transmitting vessels near Hanalei Bay, and propagation modeling suggesting the sonar transmissions would have been audible at the mouth of Hanalei Bay (Southall *et al.* 2006; Brownell *et al.* 2009). In 2008 approximately 100 melon-headed whales stranded within a lagoon off Madagascar during high-frequency multi-beam sonar use by oil and gas companies surveying offshore. Although the multi-beam sonar cannot be conclusively deemed the cause of the stranding event, the very close temporal and spatial association and directed movement of the sonar use with the stranding event, the unusual nature of the stranding event, and that all other potential causal factors were considered unlikely to have contributed, an Independent Scientific Review panel found that multi-beam sonar transmissions were a “plausible, if not likely” contributing factor (Southall *et al.* 2013) in this mass stranding event. This examination together with that of Brownell *et al.* (2009) suggests melon-headed whale may be particularly sensitive to impacts from anthropogenic sounds. No estimates of potential mortality or serious injury are available for U.S. waters.

KOHALA RESIDENT STOCK

POPULATION SIZE

Using the photo-ID catalog of individuals encountered between 2002 and 2009, Achettino (2010) used a POPAN open-population model to produce a mark-recapture abundance estimate of 447 (CV=0.12) individuals. The dataset used in this analysis is more than 8 years old, and there is no current estimate of abundance for this stock.

Minimum Population Estimate

There is no current minimum population estimate for the Kohala resident stock of melon-headed whales. The data used in the 2002-2009 mark-recapture estimate (Achettino 2010) are considered outdated, and therefore are not suitable for deriving a minimum abundance estimate.

Current Population Trend

Only one abundance estimate is available for this stock, such that there is insufficient information to assess population trends.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population estimate times one half the default maximum net growth rate for cetaceans ($\frac{1}{2}$ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997). Because there is no minimum population size estimate for this stock, the PBR is undetermined.

STATUS OF STOCK

The Kohala resident stock of melon-headed whales is not considered strategic under the MMPA. The status of this stock relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Melon-headed whales are not listed as “threatened” or “endangered” under the Endangered Species Act (1973), nor designated as “depleted” under the MMPA. There have been no reports of recent mortality or serious injuries; however, there is no systematic monitoring of takes in near-shore fisheries that may take this species. Given noted bullet holes and potential line injuries on individuals from this stock, insufficient information is available to determine whether the total fishery mortality and serious injury for Kohala Resident melon-headed whales is insignificant and approaching zero mortality and serious injury rate. The very restricted range and small population size of Hawaii Island resident melon-headed whales suggests this population may be at risk due to its proximity to U.S. Navy training, including sonar transmissions, in the Alenuihaha Channel between Hawaii Island and Maui (Forney *et al.* 2017). Although a 2004 mass-stranding in Hanalei Bay, Kauai could not be conclusively linked to Naval training events in the region (Southall *et al.* 2006), the spatiotemporal link between sonar exercises and the stranding does raise concern on the potential impact on the Kohala Resident population due to of sonar training nearby.

HAWAIIAN ISLANDS STOCK

POPULATION SIZE

Encounter data from shipboard line-transect survey of the entire Hawaiian Islands EEZ were recently reevaluated for each survey year, resulting in the following abundance estimates of melon-headed whales in the Hawaii EEZ (Bradford *et al.* 2021; Table 1).

Table 1. Line-transect abundance estimates for melon-headed whales derived from surveys of the entire Hawaii EEZ in 2002, 2010, and 2017 (Bradford *et al.* 2021).

Year	Abundance	CV	95% Confidence Limits
2017	40,647	0.74	11,097-148,890
2010	8,743	1.01	1,685-45,375
2002	9,024	1.08	1,602-50,821

The updated design-based abundance estimates use sighting data from throughout the central Pacific to estimate the detection function and use Beaufort sea-state-specific trackline detection probabilities for bottlenose dolphins from Barlow *et al.* (2015), as there is insufficient sample size to estimate $g(0)$ values for melon-headed whales. Although previous estimates from the Hawaii EEZ have been published using subsets of this data, Bradford *et al.* (2021), uses a consistent approach for estimating all abundance parameters and resulting estimates are considered the best available estimates for each survey year. The best estimate of abundance for this stock is from the 2017 survey, or 40,647 (CV=0.74) whales. An abundance estimate of melon-headed whales is available for the eastern tropical Pacific (Wade and Gerrodette 1993), but it is not known whether any of these animals are part of the same population that occurs around the Hawaiian Islands.

Minimum Population Estimate

The minimum population size is calculated as the lower 20th percentile of the log-normal distribution (Barlow *et al.* 1995) of the 2017 line-transect abundance estimate (Bradford *et al.* 2021) or 23,301 melon-headed whales.

Current Population Trend

The three available abundance estimates for this stock have very broad and overlapping confidence intervals, precluding robust evaluation of population trend for this stock. Because of the relatively large group sizes observed for melon-headed whales (average 150-200 animals), a substantial increase in abundance can be realized with very few additional sightings (one each in 2002 and 2010 versus three in 2017). Alternative approaches will be required to examine population trend in melon-headed whales.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population estimate for the U.S. EEZ of the Hawaiian Islands (23,301) times one half the default maximum net growth rate for cetaceans ($\frac{1}{2}$ of 4%) times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of 233 melon-headed whales per year.

STATUS OF STOCK

The Hawaiian Islands stock of melon-headed whales is not considered strategic under the 1994 amendments to the MMPA. The status of this stock relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Melon-headed whales are not listed as “threatened” or “endangered” under the Endangered Species Act (1973), nor designated as “depleted” under the MMPA. There have been no reports of recent mortality or serious injuries; however, there is no systematic monitoring of takes in near-shore fisheries that may take this species. Given noted bullet holes and potential line injuries on individuals from this stock, insufficient information is available to determine whether the total fishery mortality and serious injury for Hawaiian Islands melon-headed whales is

insignificant and approaching zero mortality and serious injury rate. A 2004 mass-stranding of melon-headed whales in Hanalei Bay, Kauai occurred during a multi-national sonar training event around Hawaii (Southall *et al.* 2006). Although the event could not be conclusively linked to Naval training events in the region (Southall *et al.* 2006), the spatiotemporal link between sonar exercises and the stranding does raise concern on the potential impact on the Hawaiian Islands population due to its frequent use of nearshore areas within the main Hawaiian Islands.

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